THE WRITING MACHINE

BY
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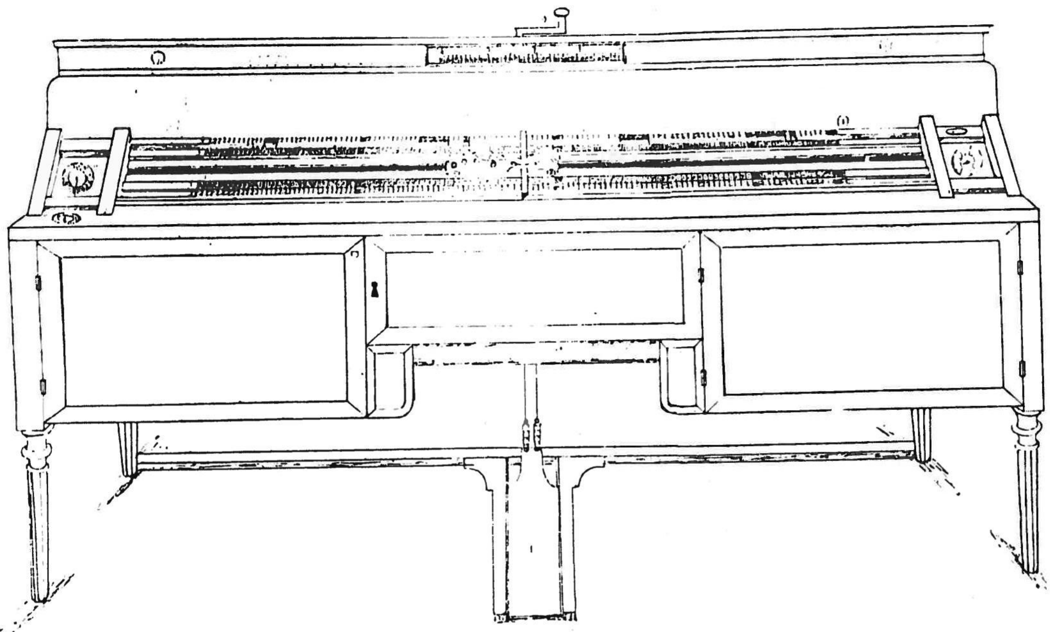
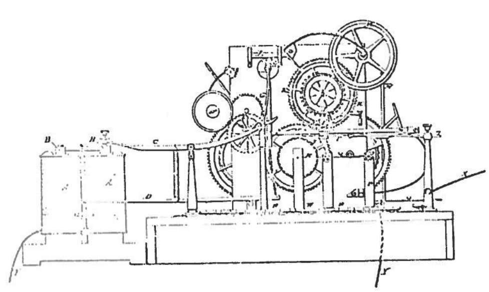


84. Abbé Clément's secret weapon against 'Morality and the Régime' was this linear plunger device built in 1855 and patented two years later. (FP)

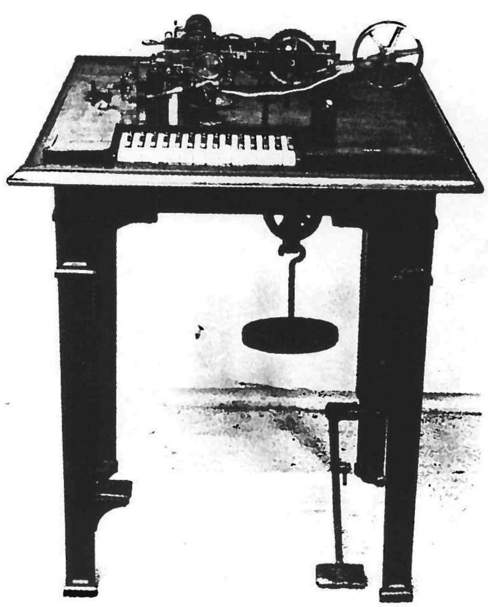
except that, pride and human frailty being what they are, he could not resist the temptation of showing the list to the children, one of whom squealed on him. The Count d'Aunay was horrified: writing machines were highly dangerous inventions, he raged, because anybody without even the help of a printer could produce and distribute pamphlets and flyleafs not only against morality but even against the Régime! And so the poor priest paid for his sins by sinking into oblivion, but not before applying for a patent which was granted in 1857. His table-sized machine was of the plunger type, with a manual selector and a pedal for making the impression on the flat paper-carriage. The type-carrier ran on rails and its length was determined by the number of alphabets, placed end to end,

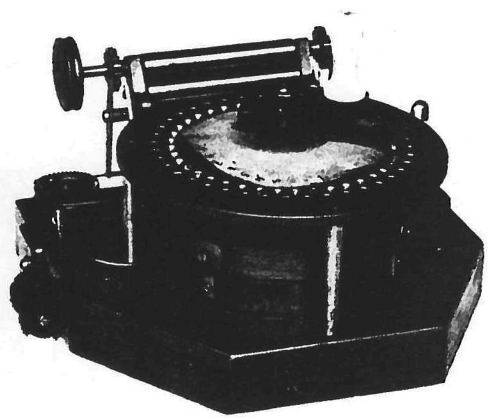


85. One of the most famous printing telegraphs ever designed was the one by D. E. Hughes of Kentucky, patented in 1856. It was of comb and pin barrel design. (USP)

that the operator desired. A dial on the left of the machine indicated the number of lines typed and another, on the right, the length of these lines. All in all, it was hardly a machine with which to assail the Régime let alone morality!

It was while the Abbé was sinking into oblivion that another inventor in the more liberal United States was rising out of it. D. E. Hughes of Kentucky (no relation to G. A.) invented his important printing telegraph in 1855 and patented





87. The carriage and platen rocked forward to strike the type on Cooper's 1856 invention. (SIW)

86. The Hughes machine was extensively used throughout the world and different models evolved from country to country. The one illustrated was the British version. (CSM)

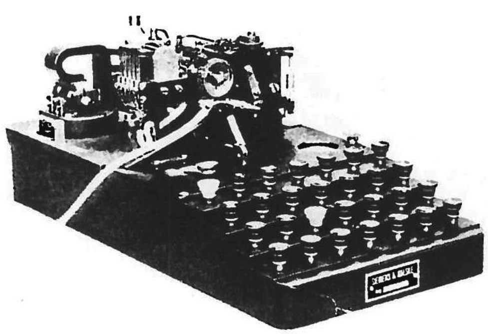
it the following year. As in Brett's and House's machines of a decade before, the Hughes used clockwork to drive a constantly revolving pin barrel which controlled type-wheels rotating 'in harmony' on both transmitter and receiver, if all went well—for such systems always suffered from difficulties in maintaining accurate synchronization. Nevertheless, the machine was used throughout the world and, over the years, many improved models were developed in different countries: by Froment in France, Siemens in Germany, and so on. There was nothing revolutionary about Hughes's design, of course, but the Jury of the 1867 Paris Exhibition considered his 'the best of all the type printing telegraphs'.

MPM John Cooper of Philadelphia made less of an impact. Like Hughes, he borrowed heavily from his contemporaries on the machine which he invented in 1856, but the product was less noteworthy. A wheel bearing the type was mounted on a vertical shaft above which a lever selected the character on a circular index. Alignment was by conical countersinks, and inking by roller. The paper was transported in a carriage automatically advanced by a ratchet escapement: this carriage

6 PRINTING TELEGRAPH

In introducing the subject of this book, an attempt was made to place the whole question of writing machines and their development in its proper historical perspective. The claims of early typewriter fanatics were rejected and it was made clear that our machine was not the most important development of the last century, nor anywhere near it. In fact, it comes quite modestly low on the list of important inventions. It was, however, intimately associated with another innovation, the telegraph, which comes preciously close to grabbing top honours, and the typewriter probably owes a greater debt to telegraphy than to any other single influence in its history.

The telegraph was extensively theorized from as early as the second half of the eighteenth century, and many fantastic schemes were proposed for transmitting messages between two distant points. Research was intensified in the early nineteenth century, and progressed hand in hand with developments in the many applications of electricity. In fact, man's fascination with the 'electric fluid' characterizes this period, much as his earlier fascination with mechanics led to the vogue for complicated automatons and so on. The wildest example is perhaps the discovery of electrolysis and its application to telegraphy by Sömmering in 1809: as the inventor would have it, the message was transmitted in the form of



207. Siemens and Halske printing telegraph transmitter, as it appeared around the turn of the century. From an old trade handbook.

electrical impulses which were to be used to liberate hydrogen at the receiver. As many wires were used as there were characters to be transmitted: sending an impulse over the 'A'-line would cause bubbles to rise above that letter at the receiver.

Telegraphy, in its practical form, however, followed close on the discovery of electromagnetism, and the contributions of Morse, Bain, Cooke, Wheatstone and others have been described in Chapter Three. These were only some of the more famous offspring sired by Ampère in 1820 when he successfully transmitted signals electromagnetically over twenty-six wires, one for each character—and without using bubbles, either.

A history of telegraphy is not, however, within the scope of this book, except

where these early systems inspired printing telegraphs. For it was almost immediately evident that a permanent record of messages was essential. Initially, the operator received transitory signals, either visible or audible, which he had to transcribe. Both were fraught with problems: the visual method, consisting of a scale of characters on which a moving needle picked out the message, was slow not only of transmission but also of reception, for the operator had to watch both the scale and the piece of paper on which he was writing. The audible method was hardly better, for while speed of operation was increased, highly skilled operators were required. In both methods, the presence of the operator at the receiver was essential at all times; if any part of the message were missed, it was gone for ever, and there was no means of checking and correcting mistakes.

A telegraphic system which would leave a permanent record of the message was clearly the solution to all these problems. Ideally, and in the form it assumed when it reached finality, the receiving apparatus should print out the message in Roman characters simultaneously with its transmission from a machine which would require no greater skill from the operator than the use of a typewriter keyboard. The development of such a printing telegraph was no mean feat, however, and a detailed study of every innovation is beyond the scope of this book. To give some idea of the magnitude of such a task, Zetzsche[44] claimed that he selected only about fifty of the most important inventions prior to 1877 and left out the rest for lack of space!

The earliest permanent record system was electrolytic, the coded message being recorded by discolouration of a strip of litmus at the receiver. This was a decade or so before Morse and his associates produced only marginally more satisfactory records by embossing a code of long and short lines on a paper tape moved at constant speed by clockwork. And then, within a matter of years, virtually every major country in the world had its telegraph system, using to a greater or lesser extent the contributions of Bain, Cooke, Wheatstone, Brett, House and others already mentioned. Almost all of these were made obsolete by the Hughes machine of 1855 which underwent transformations in many countries—in France by Froment, Germany by Siemens and Halske etc.—and achieved almost universal acceptance.

Essentially, this printing telegraphic principle had now virtually reached finality. Numerous other developments were made, by Higgins, Steljes, Baudot, Hoffman, Essick, Barclay, Burry, and so on, but these were merely refinements of existing devices in various combinations. In essence, the operator typed the message at one end on the transmitter, while one or more receivers picked it up and typed it out at the other end. A somewhat late yet good example of this kind of instrument was the Yetman Transmitting Typewriter, introduced in 1903. Although it enjoyed only a brief existence, this type-bar machine was reported to have left a precise and perfect record of the message such as might be obtained from any typewriter, while simultaneously transmitting it in Morse.

This kind of machine, however, suffered from several disadvantages, not the

least of which was the fact that utilization of the telegraphic line was limited to the speed of the operator—clearly, the line would take messages at a faster rate than a man was capable of typing them out. Several ways of increasing line capacity were devised, firstly by the simultaneous transmission of several messages on the same line, and then by the use of the automatic telegraph system, 'automatic' meaning that messages were transmitted by mechanical rather than by manual means.

Essentially, the 'automatic' principle involved perforating the message on a tape which was subsequently fed through a transmitter. The speed of transmission no longer depended on the speed of the operator, who could perforate at his leisure, but solely on the technical capabilities of the machine. Several perforators could therefore be employed to feed a single transmitter; on the other hand, this system involved the additional labour of feeding the tape into the machine, and was at first limited in its use to those lines where traffic was heavy. Otherwise, the additional staff requirement made it uneconomical.

Automatic systems began with primitive instruments such as those introduced by the ubiquitous Wheatstone in 1867. A small perforator with three keys for dashes, dots and spaces punched the message out in Morse on the paper tape; at the receiving end, the signals were recorded as inked dots and dashes on similar tape. The method was basic, yet transmission speed was increased from roughly twenty-five words per minute (on manual systems) to seventy w.p.m.

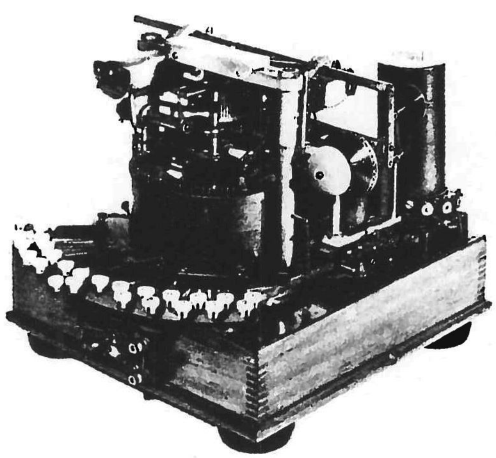
More sophisticated instruments soon followed; the obvious step, taken by Allan, Siemens, Creed, Kotyra, Kleinschmidt, Gell and others, was to utilize a typewriter keyboard perforator in which the Morse combinations of dots and dashes were automatically punched out as the corresponding key was depressed. And there were further refinements as well: Creed first introduced a re-perforator reproducing the original perforated tape at the receiving end (thus making re-transmission easy and automatic), and then a printer into which this re-perforated tape was fed and which automatically typed the message in Roman letters. As a result of his and other developments, by Baudot, Murray, Krumm, Siemens and Halske and others, transmission speeds reached 600 words per minute by the turn of the century.

However, manual systems continued to have their applications despite the advent of automation, and, in fact, are used to this day, while towards the end of the nineteenth century, a machine was introduced which appeared destined to revolutionize manual telegraphy. Till then, manual systems suffered either from the slowness inherent in the early 'step by step' principle, or else from difficulty in achieving and maintaining accuracy in timing transmitters and receivers in the synchronous systems. This was the great failing of the Hughes-based instruments.

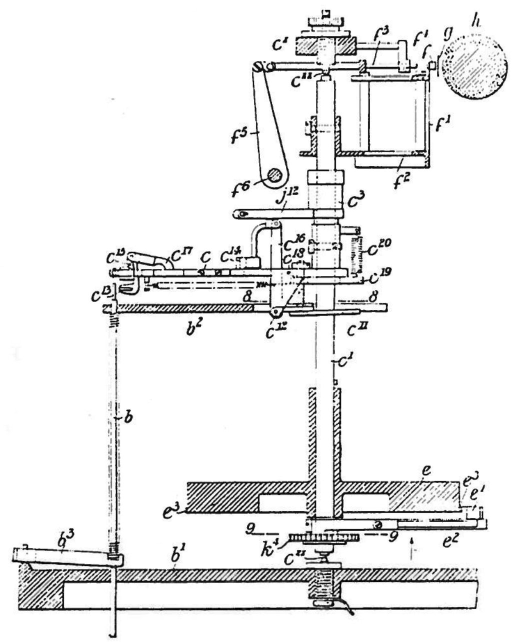
In solving these problems, 'start-stop' telegraphy was conceived, and from it was born the teleprinter and teletype as we know them today. Very simply, the start-stop system is one in which both transmitter and receiver are in phase in their positions of rest, and return to this position after each signal. Both instru-

ments thus operate normally during transmission, except that a special signal to 'start' precedes the transmission of each character signal, whereupon a 'stop' signal orders the printer back into its rest position.

The invention of start-stop telegraphy has been incorrectly attributed[19] to Krumm in 1907, and the American Morkrum machine which developed out of



208. 'The most wonderful of all': Kamm's Zerograph, with its contact arm to the extreme left in the 'zero' position. Note the segmental comb. (AC)



209. Details of the Zerograph printing action. (BP)

his device was introduced around 1920. About the same time Creed came out with a similar instrument in England.

However, the machine which was to initiate this telegraphic revolution was neither of the above. Mares[27] writes: 'Wonderful as the previously mentioned adaptations of the typewriter (to telegraphy) may be, probably the most wonderful of all is the machine to which we now make reference, namely, the Zerograph of Mr Leo Kamm, of London.' This was written in 1909, the year in which Karrass[25] described the Zerograph in detail—it had apparently been set up in the Berlin Postal Museum in 1898 and was still there at the time of his writing. Further back, the *Scientific American*[67] gave a detailed account of the instrument in 1903.

Kamm took out numerous patents (1895, 1898, 1901, 1905) and worked on the machine as well as on its promotion over a twenty-year period; considering the excellence of its design and the enthusiasm of its reception it is remarkable

that nothing concrete materialized. It was never manufactured; Kamm's appears to be the honour, however, of having built the first start-stop printing telegraph. The instrument was of the swinging sector group, employing a comb not unlike that of Wheatstone. An electromagnetic 'hammer' was also employed, and carriage return and line spacing were achieved automatically at the end of a line, a clock spring keeping the carriage under tension. A semi-circular two-row keyboard printed upper case only.

The start-stop mechanism, from which the machine derived its name, was in some respects not unlike that of a Hammond: on depression of a key, the type-sector was released and swung, or rather was pushed, around by a spring until its arm made contact with a protruding pin corresponding to that character, whereupon the hammer struck the type against the paper and the sector was pulled back to its rest or 'zero' position electromagnetically, in readiness for the depression of the next key. The 'zero' position was at the extreme left of the type-sector instead of in the centre, as it was in the Hammond. An identical machine at the receiving end performed the same operation: its type-sector was released and stopped by the signal transmitted either by telegraph or by wireless. One of Kamm's instruments is illustrated in figure 208: this unit is perhaps the only example of his work to have survived.

'In view of the possibility of development of this machine, there would seem to be no reason why a man sitting at his Zerograph in London, may not, in the future, be able to hold written converse with his correspondents in the furthermost parts of the globe, without the intervention of any actual physical connection.'[27]

7 CIPHER MACHINES

Man has been fascinated with cryptology for thousands of years and the art has played an important part in military and diplomatic history for almost as long as this has been recorded. The advent of the practical and successful typewriter during the last century should have created a veritable revolution in cryptography; after all, the desire to print a ciphertext automatically must have been one of the dreams of cryptologists for centuries. A typewriter with a standard keyboard but random letter order on type-bars or -wheel should do it: merely typing out the message would automatically encode it as it is being printed.

It sounds too good to be true—and it is! Unfortunately, cryptanalysis had reached advanced and sophisticated levels by the time the typewriter appeared. A ciphertext such as the one produced by the above-mentioned machine could have been read off by even an amateur cryptologist in only slightly more time than it would have taken him to read off the plaintext. Such simple substituion ciphers are worthless, and the reason is easily understood. If 'E' on the keyboard of our cipher typewriter prints 'g', or '+' or '6' or whatever character we have chosen (and it makes no difference what this character is), then every time we depress the 'E' key, we shall print the same symbol, and so on with every other letter of the alphabet. A cryptanalyst has merely to add up the frequency of the